# RECLAMATION CRITERIA FOR WELLSITES, BATTERIES AND ASSOCIATED FACILITIES

## Volume I: 2004 RECLAMATION CRITERIA

**April 16, 2004 DRAFT**

DRAFT – April 16, 2004

NOTE: The *Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update* remains in effect until further notice.

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## PREFACE

As part of the new Upstream Oil and Gas Reclamation and Remediation Program, Alberta Environment, in consultation with the Alberta Research Council and the University of Alberta Department of Renewable Resources, is proposing a revision of the Reclamation Criteria for Wellsites and Associated Facilities - 1995 Update.

An updated draft criteria has been developed with input from practicing reclamation consultants.

**** Note: the Reclamation Criteria for Wellsites and Associated Facilities - 1995 Update remains in effect for current applications and will be the basis for reclamation work until further notice.****

Comments on the present draft criteria begin the evaluation and refinement process, Based on this initial input, the Department will undertake revisions and prepare plans for pilot field testing. The pilot field testing phase will be used to evaluate assessment procedures, criteria, results and costs under both the 1995 criteria and proposed new criteria. Timing of the pilot testing will depend on the nature of review comments and the scope of revision necessary. A decision on whether to proceed with the proposed reclamation criteria, will be dependent on the results of this evaluation and further consultation with stakeholders.

Comments on the present draft criteria will be accepted by mail, fax or e-mail to Alberta Environment by **June 21, 2004**.

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## SUMMARY

This draft reclamation criteria document is the first volume in a three volume series[1] developed to replace the *Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update*. These criteria have been developed using the experience of government, industry, landowners and other stakeholders.

The certification criteria apply to wellsites, batteries, access roads and associated facilities such as borrow pits, campsites and off-site sumps. They do not apply to facilities or features that are left in place such as access roads, pads, dugouts etc. with the landowner's written approval, although these facilities or features will be covered by the reclamation certificate.

Under Section 137 of the *Environmental Protection and Enhancement Act* (EPEA), operators must conserve, reclaim and obtain a reclamation certificate for specified land. Specified lands include those lands used for or held in connection with upstream oil and gas facilities. In order to be eligible for a Reclamation Certificate a pipeline, wellsite or battery and their associated facilities must meet remediation and reclamation criteria as required by Alberta Environment (AENV).

The goal of reclamation is to attain equivalent land capability[2]. Equivalent land capability is achieved once all criteria have been met. Proper construction, operation, remediation and reclamation practices set the stage for successfully achieving equivalent land capability. These practices include activities like salvage and replacement of surface soils, two-lift stripping, minimum disturbance and natural revegetation techniques. Post-reclamation conditions are compared with pre-disturbance or adjacent conditions to help determine whether reclamation success has been achieved. The timelines in the criteria provide due consideration for the construction norms used when development occurred.

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[1] *Reclamation Criteria for Wellsites and Associated Facilities – 2003 Update: Vol. 1 Reclamation Criteria; Vol. 2 Assessment Protocol, Vol. 3 Technical Rationale.*

[2] Equivalent Land Capability is defined as "the ability of the land to support various land uses after conservation and reclamation is similar to that which existed prior to an activity being conducted on the land but the individual land uses will not necessarily be identical"



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The reclamation criteria consist of three documents. The first document, *Volume I: 2004 Reclamation Criteria*, is the criteria that specify the reclamation endpoints that must be met before a reclamation certificate can be issued.

The second document, *Volume II: 2004 Assessment Protocol*, comprises the assessment protocol that requires specific field sampling and lab analysis protocols for pre-construction, and subsequent site assessments.

The third document, *Volume III: Technical Rationale Document*, provides the scientific basis for the criteria that ensure that the criteria are based in science to the maximum extent possible, as well as being practical.

Successful application of the criteria requires accurate assessment of landscape, soil and vegetation parameters. The criteria document details four land use categories (Cultivated Land, Grassland, Forested Land and Peat Land). General procedures for assessment and reporting are described. **It is important to note that the criteria and assessment procedures differ between categories**.

Changes have occurred in both the criteria values and the assessment procedures specified in the *Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update*. The new criteria contain new parameters and more exact measurement requirements. Target criteria values for several parameters are affected by the facility construction date. Of special note, topsoil replacement requirements are illustrated in Table 1 on following page.

Criteria values have been enhanced from the *Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update* to include:

- Allowable clay content increase limited to 8% for Cultivated Land, Grassland and Forested Land
- Organic matter retention of 90% required for sites constructed on, or after the release date of these criteria for Cultivated, Grassland and Forested Land

[3] Located at the AENV's Publications link at: http://www.gov.ab.ca/env/protenf/soilgrndwater/index.html



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- Sites constructed prior to the release date of these criteria are subject to organic matter retention requirements of 70% or 80%, or may be subject to alternate requirements where permanent plant cover has been established
- No direct estimation of admixing – inferred from organic C and clay content
- Allowable gravel and rocks increase limited to 10%

**Table 1. Topsoil Replacement Requirements by Land Use based on Construction Date**

| Land Use | Replacement Requirements |
|---|---|
| **Cultivated Land** | • **For sites constructed on or after the release date of these criteria:** ≥ 90% of the average control or PCSA[4] values<br>• **For sites constructed between April 1, 1983 and the release date of these criteria:** ≥ 80% of the average control or PCSA values<br>• **For sites constructed prior to April 1, 1983:** ≥ 70% of the average control or **PCSA** values |
| **Grassland** | • **For sites constructed on or after the release date of these criteria:** ≥ 90% of the average control or PCSA values<br>• **For sites constructed between May 1, 1994 and the release date of these criteria:** ≥ 80% of the average control or PCSA values<br>• **For sites constructed prior to May 1, 1994:** ≥ 60% of the average control or PCSA values |
| **Forested Land** | • **For sites constructed on or after the release date of these criteria:** ≥ 90% of the average control or PCSA values<br>• **For sites constructed prior to the release date of these criteria:** Replace all salvaged surface soil to uniform depth |
| **Peat Land** | • Replace all salvaged surface soil to uniform depth<br>• A minimum replacement depth of 15 cm is required where off-site control or PCSA is < 40 cm |

[4] **PCSA** – pre-construction site assessment



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## 1 LAND USE CATEGORIES

The four land use categories are described below. In situations where a site is constructed on land supporting two different land uses (e.g., cultivated land and forest land), the landowner on private lands or landowner/land manager for public lands (Alberta Sustainable Resource Development. (ASRD) will determine the final land use for the site. The operator should secure written authorization from the landowner indicating the accepted land use.

**Cultivated Land** – Lands that have been continuously tilled or cropped and have a well-defined Ap horizon, including cultivated peat lands. These Cultivated Land criteria apply to lands under continuous and rotational cropping systems, haylands and forested lands that have been converted to continuous cropping or hayland systems. These Cultivated Land criteria do not apply to range improvement areas in grazing dispositions or reserves, which are assessed under the Grassland criteria.

**Grassland** – Lands that are permanently grassed including, but not limited to, range improvement areas, grazing dispositions on public lands (White Area or Green Area), native prairie and grassland areas, Special Areas Board land, and Eastern Irrigation District land. Note that grasslands that have a well-defined Ap horizon, and have a reasonable likelihood of cultivation, will be assessed under the Cultivated Land criteria.

**Forested Land** – Treed (bush) lands that are allowed to revert to forest or planted to forest species. These areas are either designated for multiple uses (e.g., wildlife habitat, recreation) or for timber production. They include a mixture of private and public land. Many forested lands have severe limitations (e.g., soils, topography, access) that preclude cultivation. Land that has been converted to continuous cropping or hayland should be assessed under the Cultivated Land criteria. Land that has been converted to rangeland should be assessed under the Grassland criteria.

**Peat Land** –Peat Land is found in poorly or very poorly drained depressions and level areas, and is saturated with water for prolonged periods. Soils are composed largely of organic materials, and are commonly known as peat, muck or bog soils. Peat Land may or may not be treed. The criteria apply only to those peat soils that have not been cultivated. All cultivated peat soils are dealt with under the Cultivated Land criteria.



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## 2 SITE ASSESSMENT

Refer to **Volume II: Assessment Protocol**

## 3 CULTIVATED LAND

**Table 2. Reclamation Criteria for Cultivated Land**

| ASSESSMENT FACTOR | CULTIVATED LAND |
|---|---|
| **LANDSCAPE CRITERIA (Section 3.1)**[6] The differences between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no negative impact, either on or off-site. | |
| **Drainage** | • Site drainage must be consistent with original patterns, directions and capacity, otherwise compatible with the surrounding landscape<br>• Facilities or features left in place (e.g., clay pads, access roads) must not negatively impact drainage |
| **Contours** | • Contour and roughness must conform and blend with the adjacent contours, or be consistent with the present or intended land use |
| **Stability** | • Site must be geotechnically stable (no visible slope movement, slumping, subsidence, tension cracks)<br>• Site must be stable from erosion (No rills, fans, gullies, raised pebbles, plant pedestals, increased topsoil depth along fence lines or ditches) |
| **Debris** | • Industrial or domestic debris is not allowed<br>• Woody debris (roots, slash) on previously forested land must not interfere with normal use of reclaimed land or future management practices of the landowner |
| **Gravel and Rocks (Section 3.1.1)**<br>***Quadrant sampling***<br>***4 Controls*** | • < 10% increase in gravel (≤ 8 cm)<br>• No increase in rocks (> 8 cm)<br>• No piles or windrows |

[6] Section indicated refers to associated section in Volume II: Assessment Protocol.



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| ASSESSMENT FACTOR | CULTIVATED LAND |
|---|---|
| **SOIL CRITERIA (Section 3.2)** Differences in soil characteristics between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no adverse impact on vegetative growth. | |
| **Topsoil Replacement Depth (Section 3.2.1)** | |
| **Replacement Depths**<br>*Full grid sampling*<br>*8 controls* | **Sites constructed on or after the release date of these criteria:**<br>• Each grid must be ≥ 90% of the average control or PCSA depth<br>**Sites constructed after April 1, 1983 to the release of these criteria:**<br>• Each grid must be ≥ 80% of the average control or PCSA depth<br>**Sites constructed prior to April 1, 1983:**<br>• Each grid must be ≥ 70% of the average control or PCSA value |
| **Topsoil Quality (Section 3.2.2)** | |
| **Texture (Particle Size Analysis (PSA)) (Section 3.2.2.1)**<br>*Alternate grid sampling*<br>*8 controls* | • If average control clay content > 50%, no increase in average clay content is allowable<br>• If average control clay content is ≤ 50%<br>  • an increase resulting in average on-site clay content exceeding 50% is not allowable, and<br>  • an increase in average clay content >8% is not allowable |
| **Aggregate Size Class Distribution (Section 3.2.2.2)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | **Sites constructed on or after the release date of these criteria:**<br>• Same relative size class distribution as pre-construction or off-site control<br>• On-site aggregate size class distribution compared to PCSA or control<br>  • ≤ 20% increase permissible for 2 cm to < 5 cm class<br>  • ≤ 10% increase permissible for 5 cm to ≤ 10cm class<br>  • No increase allowed for >10 cm class<br>**Sites constructed prior the release date of these criteria:**<br>• Remain in same aggregate size class as control |
| **Bulk Density (Section 3.2..2.3)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • No increase in bulk density is allowable as compared to the highest control value for equivalent soil layers |



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| ASSESSMENT FACTOR | CULTIVATED LAND |
|---|---|
| **Organic Matter Content** (Section 3.2.2.4)<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | When organic amendments have been used, a minimum three-year period without further organic matter additions is required prior to certification application<br>**Sites constructed on or after the release date of these criteria:** (≥ 90% topsoil replacement depth)<br>• A decrease in total organic carbon ≤ 10% is permissible in replaced topsoil assessment volume compared to pre-construction or control value<br>**Sites constructed between April 1, 1983 and the release of these criteria** (≥ 80% topsoil replacement depth)<br>• A decrease in total organic carbon ≤ 20% is permissible in replaced topsoil assessment volume compared to pre-construction or control value<br>**Sites constructed prior to April 1, 1983** (≥ 70% topsoil replacement depth)<br>• A decrease in total organic carbon ≤ 30% is permissible in replaced topsoil assessment volume compared to pre-construction or control value |
| **SOIL PROFILE CRITERIA** (Section 3.3) Characteristics of soil profiles as a rooting medium must not indicate adverse impact as a result of industrial, and reclamation activities. | |
| **Process Restrictions** (Section 3.3.1)<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls, plus*<br>*Areas of concern identified by Penetrometer Resistance* | • There must not be evidence of surface water ponding, root restriction, or compacted soil layering<br>• Process restriction indicators (Appendix 2) must be equivalent to, or less restrictive than off-site control to a minimum depth of 60 cm<br>• For valid vegetation comparison, on-site vegetation must be equivalent to off-site control |
| **Penetrometer Resistance** (Section 3.3.2)<br>*Full grid sampling*<br>*8 controls* | • No increase in penetrometer resistance is allowable as compared to the highest control value for equivalent soil layers under similar moisture conditions |
| **VEGETATION CRITERIA** (Section 3.4) A comparison of vegetative characteristics between the reclaimed site and adjacent land must not show adverse impact as a result of industrial, and reclamation activities. | |
| **Species Composition** (Section 3.4.1)<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Type and mix of species must be compatible with original or control species<br>• No restricted weeds are allowed on-site<br>• Nuisance and noxious weeds must not exceed the degree or extent of off-site infestation |



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| ASSESSMENT FACTOR | CULTIVATED LAND |
|---|---|
| **Yield Potential (Section 3.4.2)**<br>*Grid sampling*<br>*8 controls* | **Sites constructed on or after the release date of these criteria:**<br>• Yield values for each sample point must be greater than the minimum control value, and<br>• The average on site yield must be >90% of the average control value<br>**Sites constructed prior to the release date of these criteria:**<br>• Yield values for each sample point must be greater than the minimum control value, and<br>• The average on site yield must be >80% of the average control value |
| **Biomass for Forages (Section 3.4.3)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | **Sites constructed on or after the release date of these criteria:**<br>• Forage biomass for each quadrant must be greater than the minimum control value, and<br>• The average on site forage biomass must be > 90% of the average control value<br>**Sites constructed prior to the release date of these criteria:**<br>• Forage biomass for each grid must be greater than the minimum control value, and<br>• The average on site forage biomass must be > 80% of the average control value |
| **Sustainable Plant Community (Health) (Section 3.4.4)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Plant health characteristics such as vigour, height, color, and disease must be equivalent to control |



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## 4 GRASSLAND

**Table 3. Reclamation Criteria for Grassland**

| ASSESSMENT FACTOR | GRASSLAND |
|---|---|
| **LANDSCAPE CRITERIA** (Section 4.1) The differences between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no negative impact, either on or off-site. | |
| **Drainage** | • Site drainage must be consistent with the original patterns, directions and capacity, or otherwise compatible with the surrounding landscape<br>• Facilities or features left in place (e.g., clay pads, access roads) must not negatively impact drainage |
| **Contours** | • Contour and roughness must conform and blend with the adjacent land, or be consistent with the present or intended land use |
| **Stability** | • Site must be geotechnically stable (no visible slope movement, slumping, subsidence, tension cracks)<br>• Site must be stable from erosion (no rills, fans, gullies, raised pebbles, plant pedestals, increased topsoil depth along fence lines or ditches) |
| **Debris** | • Industrial and domestic debris is not allowed<br>• Woody debris must not interfere with normal use of adjacent land or future management practices of the landowner |
| **Gravel and Rocks** (Section 4.1.1)<br>*Quadrant sampling*<br>*4 controls* | • < 10% increase in gravel (≤ 8 cm)<br>• ≥ 10% increase in gravel in a loamy sand, or sand textured soil is permissible only with permission of landowner and/or inspector<br>• No increase in rocks (> 8 cm)<br>• No piles or windrows |



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| ASSESSMENT FACTOR | GRASSLAND |
|---|---|
| **SOIL CRITERIA (Section 4.2)** Differences in soil characteristics between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no adverse impact on vegetative growth. | |
| **Topsoil Replacement Depths (Section 4.2.1)** | |
| **Replacement Depths**<br>*Full grid sampling*<br>*8 controls* | • Variability in topsoil replacement depth reflecting off-site control grassland conditions is permissible<br>**Sites constructed on or after the release date of these criteria:**<br>• The average topsoil depth on the site must be ≥ 90% of the average control or PCSA value<br>**Sites constructed between April 1, 1983 and the release of these criteria:**<br>• The average topsoil depth on the site must be ≥ 80% of the average control or PCSA value<br>• In instances where a sustainable, native plant community has been reestablished for at least three years, vegetation criteria may take precedence over topsoil replacement depth criteria<br>**Sites constructed prior to April 1, 1983:**<br>• The average topsoil depth on the site must be ≥ 60% of the average control or PCSA value<br>• In instances where a sustainable, native plant community has been reestablished for at least three years, vegetation criteria may take precedence over topsoil replacement depth criteria |
| **Topsoil Quality (Section 4.2.2)** | |
| **Texture (Particle Size Analysis) (Section 4.2.2.1)**<br>*Alternate grid sampling*<br>*8 controls* | • No increase in replaced topsoil clay content is allowable where average control or PCSA clay content > 50%<br>• Where average control or PCSA clay content is ≤ 50%:<br>  • an increase that results in average on-site topsoil clay content exceeding 50% is not allowable, and<br>  • an increase in average on-site topsoil clay content >8% is not allowable<br>• In instances where a sustainable, native plant community has been reestablished for at least three years prior to the release date of these criteria, vegetation criteria may take precedence over topsoil texture criteria |



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| ASSESSMENT FACTOR | GRASSLAND |
|---|---|
| **Aggregate Size Class Distribution (Section 4.2.2.2)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | **Sites constructed on or after the release date of these criteria:**<br>• Same relative size class distribution as pre-construction or off-site control<br>• On-site aggregate size class distribution compared to the control or PCSA value<br>  • ≤ 20% relative increase permissible for 2 cm to < 5 cm class<br>  • ≤ 10% relative increase permissible for 5 cm to ≤ 10cm class<br>  • No increase allowable for >10 cm class<br>**Sites constructed prior to the release date of these criteria:**<br>• Remain in same aggregate size class as control<br>• In instances where a sustainable, native plant community has been reestablished for at least three years prior to the release date of these criteria, vegetation criteria may take precedence over soil aggregate size criteria |
| **Bulk Density (Section 4.2.2.3)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • No increase in bulk density is allowable as compared to the highest control value for equivalent soil layers |
| **Organic Matter Content (Section 4.2.2.4)**<br>*Quadrant Sampling*<br>*Well centre*<br>*4 controls* | In instances where a sustainable, native plant community has been reestablished for at least three years **prior to the release date of these criteria**, vegetation criteria may take precedence over organic matter content criteria<br>In instances where organic amendments have been used, a minimum three-year period without further organic matter additions is required prior to certification application<br>**Sites constructed on or after the release date of these criteria** (≥ 90% topsoil replacement depth):<br>• ≤ 10% decrease in total organic carbon is permissible in replaced topsoil assessment volume compared to control or PCSA value<br>**Sites constructed between April 1, 1983 and the release date of these criteria** (≥ 80% topsoil replacement depth):<br>• ≤ 20% decrease in total organic carbon is permissible in replaced topsoil assessment volume compared to control or PCSA value<br>**Sites constructed prior to April 1, 1983** (≥ 60% topsoil replacement depth):<br>• ≤ 40% decrease in total organic carbon is permissible in replaced topsoil assessment volume compared to control or PCSA value |



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| ASSESSMENT FACTOR | GRASSLAND |
|---|---|
| **SOIL PROFILE CRITERIA (Section 4.3)** Characteristics of soil profiles as a rooting medium must not indicate adverse impact as a result of industrial, and reclamation activities. | |
| **Process Restrictions (Section 4.3.1)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls, plus*<br>*Areas of concern identified by Penetrometer Resistance* | • There must not be evidence of surface water ponding, root restrictions or compacted soil layering<br>• Process restriction indicators (Appendix 2) must be equivalent to or less restrictive than, off-site control to a minimum 60 cm depth<br>• For valid vegetation comparison, on-site vegetation must be equivalent to off-site control |
| **Penetrometer Resistance (Section 4.3.2)**<br>*Grid sampling*<br>*8 controls* | • No increase in penetrometer resistance is allowable as compared to the highest control value for equivalent soil layers under similar moisture conditions |
| **VEGETATION CRITERIA (Section 4.4)** Vegetative characteristics between the reclaimed site and adjacent land must not show adverse impact as a result of industrial, and reclamation activities. | |
| **Species Composition (Section 4.4.1)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Sites must be seeded with native species[7]<br>• The species planted on the site must form a sustainable desired plant community that is compatible with original or control species, or that is compatible with accepted end land use and land management objectives of the landowner<br>• Onsite introduced forage plant density must not exceed that offsite<br>• No restricted weeds are allowable onsite<br>• Nuisance and noxious weeds must not exceed the degree or extent of off-site infestation |
| **Plant Community Structure: (Section 4.4.2)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | **Sites constructed on or after the release date of these criteria:**<br>• A minimum of both overstory and understory plant layers must be present, or<br>• A minimum of one plant layer if that is the control condition<br>• Plant distribution must be comparable to controls<br>**Sites constructed prior to the release date of these criteria:**<br>• At least one plant layer is required |

[7] Native Plant Revegetation Guidelines, 2001



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| ASSESSMENT FACTOR | GRASSLAND |
|---|---|
| **Live Plant Cover / Live Plant Density and Litter (Section 4.4.3)**<br>*Grid sampling*<br>*4 controls* | **For sites constructed on or after the release date of these criteria:**<br>• Live plant cover must be ≥ 90% compared to off-site live plant cover<br>• In lieu of off-site plant cover comparison, on-site plant density must be<br>  • ≥ 10 plants/$m^2$ (grass /forb species), or<br>  • ≥ 1 plant/$m^2$ (shrubs)<br>• For water erosion high-risk sites: Ground cover comprised of live plants, litter, plus other permanent erosion control products must bring total ground cover to a minimum of 80%<br>• For all other sites: Ground cover comprised of live plants, litter, plus other permanent erosion control products must bring total ground cover to a minimum of 60%<br>**For sites constructed prior to the release date of these criteria:**<br>• Live plant cover must be ≥ 80% compared to off-site live plant cover |
| **Sustainable Plant Community (Health) (Section 4.4.4)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Above-ground plant growth must be healthy and vigorous with no more evidence of plant disease or stress than is found on controls<br>• Plants must have healthy root systems<br>• There must be evidence of successful on-site plant reproduction (e.g., seeds, rhizomes) |



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## 5 FORESTED LAND

**Table 4. Reclamation Criteria for Forested Lands**

| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **LANDSCAPE CRITERIA (Section 5.1)** The differences between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no negative impact, either on or off-site. | |
| **Drainage** | • Site drainage must be consistent with the original patterns, directions and capacity, or otherwise compatible with the surrounding landscape<br>• Facilities or features left in place (e.g., clay pads, access roads) must not negatively impact drainage |
| **Contours** | • Contour and roughness must conform and blend with the adjacent contours, or be consistent with the present or intended land use |
| **Stability** | • Geotechnically stable (no visible slope movement, slumping, subsidence, tension cracks)<br>• Stable from erosion (rills, fans, gullies, raised pebbles, plant pedestals, increased topsoil depth along fence lines or ditches) |
| **Debris** | • Industrial or domestic debris is not allowed<br>• Slash and roots that do not interfere with forested land use should be retained where it does not conflict with current Forest Protection policy and regulations<br>• Woody debris should be retained evenly across the surface of the lease unless otherwise specified in the public land surface disposition |
| **Gravel and Rocks**<br>***Quadrant sampling***<br>***4 Controls*** | • No piles or windrows<br>• No increase in concentration of gravel and rock size compared to control |



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **SOIL CRITERIA (Section 5.2)** Differences in soil characteristics between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no adverse impact on vegetative growth. Two site assessment options are available.<br><br>**Sites constructed prior to the release date of these criteria** may be assessed with either Option A or Option B.<br><br>**All sites constructed on or after the release date of these criteria** must be evaluated with Option A. | |
| | |
| **OPTION A. SOIL AND REDUCED VEGETATION REQUIREMENTS.** This option focuses on the soil characteristics as indicators of forest potential where tree establishment has had limited time since reclamation. This option is available to all sites regardless of construction date. | |
| **SURFACE SOIL QUANTITY (Section 5.2.1)** | |
| **Surface Soil Replacement**<br>*Full grid sampling*<br>*8 controls* | • The average surface soil replacement depth of on-site samples must be ≥ 90% of the average control (or PCSA) value<br>• Surface soil depths for ≥ 50% of all sample points must be greater than or equal to the average control (or PCSA) value<br>• Surface soil depths at all sample points must be ≥ 25% of the average control (or PCSA) value |
| **SOIL QUALITY CRITERIA (Section 5.2.2)** | |
| **Texture (Particle Size Analysis) (Section 5.2.2.1)**<br>*Alternate grid sampling*<br>*Well centre*<br>*4 controls* | • If average control clay content > 50%, no increase in clay content is allowable<br>• If average control clay content is ≤ 50%, an increase in clay content >8% is not allowable |
| **Bulk Density (Section 5.2.2.3)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • No increase in bulk density is allowable as compared to the highest control value for equivalent soil layers |



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **Organic Matter Content (Section 5.2.2.4)**<br>*Quadrant Sampling*<br>*Well centre*<br>*4 controls* | • 10% decrease in total organic carbon is permissible in replaced surface soil assessment volume compared to average control or PCSA value<br>When organic amendments have been used, a minimum three-year period without further organic matter additions is required prior to certification application |
| **Process Restrictions (Section 5.3.1)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls, plus*<br>*Areas of concern identified by Penetrometer Resistance* | • There must not be evidence of surface water ponding, root restriction, or compacted soil layering<br>• Process restriction indicators (Appendix 2) must be equivalent to, or less restrictive than off-site control to a minimum 60 cm depth |
| **Penetrometer Resistance (Section 5.3.2)**<br>*Full grid sampling*<br>*8 controls* | • No increase in penetrometer resistance is allowable at any individual grid sample location as compared to average control values for similar soil layers and under similar moisture conditions |



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **VEGETATION CRITERIA (Section 5.4)** Vegetative characteristics between the reclaimed site and adjacent land must not show adverse impact as a result of industrial, and reclamation activities. | |
| **Species Composition (Section 5.4.1.)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • The species planted on the site must form a sustainable desired plant community that is, or is likely to become, similar to the original or control plant community, or that is compatible with accepted end land use and land management objectives of the landowner<br>• Tree material used in reclamation must conform to accepted standards [8] including use of seeds/stock from natural or controlled parentage programs<br>• Use of non-native, non-persistent plants (e.g. annuals) is accepted to control erosion subject restrictions noted below<br>• Acceptable plant species are those characteristic of early to mid-serial stage of the control or target plant community<br>• No restricted or noxious weeds are allowed onsite<br>• Nuisance weeds must not exceed the degree or extent of off-site infestation<br>• Problem-introduced forages on sites seeded prior to **February 1**[9]**, 2001** are permissible<br>• Problem-introduced forages on sites seeded after **January 31 2001** must be eliminated unless approved in writing by landowner |
| **Plant Community Structure (PCS): (Section 5.4.2)**<br>*Grid sampling*<br>*4 controls* | • At least one plant layer is required that may include trees or shrubs but mosses, lichens and litter cannot be consider as part of the layer<br>• Uneven plant distribution is acceptable |
| **Live Plant Cover / Live Plant Density (Section 5.4.3)**<br>*Grid sampling*<br>*Well centre*<br>*4 controls* | • The on-site average of total acceptable native and annual live plant cover (excluding all mosses and lichens) must exceed 50%, and<br>• Acceptable native species must account for greater than 30% of that total live plant cover present;<br>or<br>• Attain stocking success with acceptable trees in the assessment plots of 60% of grids |

[8] Standards for Tree Improvement in Alberta. May, 2003.
http://www3.gov.ab.ca/srd/forests/fmd/manuals/pdf/genetics21may.pdf
[9] This date coincides with the release of Native Plant Revegetation Guidelines for Alberta (2001).



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **Sustainable Plant Community (Health)**<br>**(Section 5.4.4)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Above-ground plant growth must be healthy and vigorous with no more evidence of plant disease or stress than is found off-site controls<br>• Plants must have healthy root systems |

| **OPTION B. VEGETATION ONLY CRITERIA.** This option focuses on the vegetation characteristics where tree establishment has had extended time since reclamation. There are no soil criteria with this option beyond the requirement to replace all salvaged surface soil. This option is available only to those sites constructed prior to the release date of these criteria. | |
|---|---|
| **SURFACE SOIL QUANTITY (Section 5.2.1)** | |
| **Surface Soil Replacement**<br>*Grid sampling*<br>*8 controls* | • All salvaged surface soil must be replaced to a uniform depth. |



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **VEGETATION CRITERIA (Section 5.4)** Vegetative characteristics between the reclaimed site and adjacent land must not show adverse impact as a result of industrial, and reclamation activities. | |
| **Species Composition (Section 5.4.1)**<br>**Applicable to all vegetation criteria**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • The species planted on the site must form a sustainable desired plant community that is, or is likely to become, similar to the original or control plant community, or that is compatible with accepted end land use and land management objectives of the landowner<br>• No restricted are allowed onsite<br>• Nuisance or noxious weeds must not exceed the degree or extent of off-site infestation<br>• Planted tree material must conform to the accepted standard[10], including use of seeds and stock from natural or controlled parentage programs<br>• Use of non-native, non-persistent plants (e.g. annuals) is acceptable to control erosion subject to any restrictions noted in these Forested Lands criteria<br>• Acceptable plant species are those characteristic of early to mid-seral stage of the control or target plant community<br>• Problem-introduced forages on sites seeded prior to **February 1[11], 2001** are permissible<br>• Problem-introduced forages on sites seeded after **January 31 2001** must be eliminated unless approved in writing by landowner |
| **Plant Community Structure (PCS): (Section 5.4.2)**<br>*Grid sampling*<br>*4 controls* | • A minimum of both overstory and understory plant layers must be present, or<br>• A minimum of one plant layer where that is the off-site control condition<br>• Presence of the required minimum tree cover (see Live Plant Cover / Live Plant Density section below) is considered as an acceptable overstory layer |

[10] Standards for Tree Improvement in Alberta. May, 2003.
http://www3.gov.ab.ca/srd/forests/fmd/manuals/pdf/genetics21may.pdf
[11] This date coincides with the release of Native Plant Revegetation Guidelines for Alberta (2001).



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| ASSESSMENT FACTOR | FORESTED LAND |
|---|---|
| **Live Plant Cover / Live Plant Density (Section 5.4.3)**<br>*Grid sampling*<br>*4 controls* | • Live plant cover must be ≥ 90% of similar off-site live plant cover at a similar developmental stage within the immediate area or,<br>• On-site plant density must be:<br>  • ≥ 10 plants/$m^2$ for open grassy areas, or<br>  • ≥ 80% of offsite woody species density, or<br>  • For sites planted for a minimum of three growing seasons, attain ≥ 80% stocking for conifers ≥ 30 cm in height, or for deciduous ≥ 100 cm in height<br>• Sites older than 10 years post-abandonment must:<br>  • Attain ≥ 60% stocking for trees that exceed minimum height requirements for the species, eco-region and forest type strata "Performance Standard"[12]; and<br>  • Achieve a three-year mean annual height growth increment of ≥ 15 cm for spruce, true fir and Douglas fir; ≥ 25 cm for lodgepole and jack pine; and ≥ 40 cm for aspen, balsam poplar and white birch |
| **Sustainable Plant Community (Health) (Section 5.4.4)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Above-ground plant growth must be healthy and vigorous with no more evidence of plant disease or stress than is found on off-site controls<br>• Plants must have healthy root systems |

[12] Alberta Regeneration Survey Manual. July 2003, as amended from time to time http://www3.gov.ab.ca/srd/forests/fmd/manuals/pdf/Regen_Survey_Manual.pdf



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## 7 PEAT LAND

**Table 5. Reclamation Criteria for Peat Lands**

| ASSESSMENT FACTOR | PEAT LAND |
|---|---|
| **LANDSCAPE CRITERIA** (Section 6.1) The differences between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no negative impact on or off-site. | |
| **Drainage** | • Site drainage must be consistent with the original patterns, directions and capacity, or otherwise compatible with the surrounding landscape<br>• Facilities or features left in place (e.g., clay pads, access roads) must not negatively impact drainage |
| **Contours** | • Contour and roughness must conform and blend with the adjacent contours, or be consistent with the present or intended land use |
| **Stability** | • Geotechnically stable (no visible slope movement, slumping, subsidence, tension cracks)<br>• Stable from erosion (rills, fans, gullies, raised pebbles, pedestalling of plants, increased topsoil depth along fence lines or ditches) |
| **Debris** | • Industrial or domestic debris is not allowed<br>• Slash and roots that do not interfere with forested land use should be retained where it does not conflict with current Forest Protection policy and regulations<br>• Woody debris should be retained evenly across the surface of the lease unless otherwise specified in the public land surface disposition |
| **Gravel & Rocks** | • No piles, windrows or concentrations |
| **SOIL CRITERIA** (Section 6.2) Differences in soil characteristics between the reclaimed site and adjacent land must not be significant enough to interfere with normal land use and must show no adverse impact on vegetative growth. | |
| **SURFACE SOIL QUANTITY** (Section 6.2.1) | |
| **Replacement Depths**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • A minimum replacement depth of 15 cm is required where off-site control or PCSA peat depth is < 40 cm<br>• No salvage required where off-site control or PCSA peat depth is ≥ 40 cm, provided a drill pad is used |
| **SOIL PROFILE ASSESSMENT** (Section 6.3) **n/a for Peat Land.** | |



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| ASSESSMENT FACTOR | PEAT LAND |
|---|---|
| **VEGETATION CRITERIA (Section 6.4)** Vegetative characteristics between the reclaimed site and adjacent land must not show adverse impact as a result of industrial, and reclamation activities. | |
| **Species Composition (Section 6.4.1)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • The species planted on the site must form a sustainable desired plant community that is, or is likely to become, similar to the original or control plant community, or that is compatible with accepted end land use and land management objectives of the landowner<br>• No restricted are allowed onsite<br>• Nuisance or noxious weeds weeds must not exceed the degree or extent of off-site infestation<br>• Problem-introduced forages on sites seeded prior to **February 1**[13], **2001** are permissible<br>• Problem-introduced forages on sites seeded after **January 31 2001** must be eliminated unless approved in writing by landowner |
| **Plant Community Structure: (Section 6.4.2)**<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | **Sites constructed on or after the release date of these criteria:**<br>• A minimum of both overstory and understory plant layers must be present, or<br>• A minimum of one plant layer if that is the control condition<br>**Sites constructed prior the release date of these criteria:**<br>• At least one plant layer is required |
| **Live Plant Cover / Live Plant Density (Section 6.4.3)**<br>*Grid sampling*<br>*4 controls* | • Live plant cover must be ≥ 90% of similar off-site live plant cover at a similar developmental stage within the immediate area or,<br>• On-site plant density must be:<br>  • ≥ 10 plants/$m^2$ for open grassy areas, or<br>  • ≥ 80% of offsite woody species density, or<br>  • For sites planted for a minimum of three growing seasons, attain ≥ 80% stocking for conifers ≥ 30 cm in height, or for deciduous ≥ 100 cm in height<br>• Sites older than 10 years post-abandonment must:<br>  • Attain ≥ 60% stocking for trees that exceed minimum height requirements for the species, eco-region and forest type strata "Performance Standard"[15]; and<br>  • Achieve a three-year mean annual height growth increment of ≥ 15 cm for spruce, true fir and Douglas fir; ≥ 25 cm for lodgepole and jack pine; and ≥ 40 cm for aspen, balsam poplar and white birch |

[13] This date coincides with the release of Native Plant Revegetation Guidelines for Alberta (2001).
[14] This date coincides with the release of the Native Plant Revegetation Guidelines for Alberta.
[15] Alberta Regeneration Survey Manual. July 2003, as amended from time to time
http://www3.gov.ab.ca/srd/forests/fmd/manuals/pdf/Regen_Survey_Manual.pdf



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| ASSESSMENT FACTOR | PEAT LAND |
|---|---|
| **Sustainable Plant Community (Health)** (Section 6.3.3)<br>*Quadrant sampling*<br>*Well centre*<br>*4 controls* | • Above-ground plant growth must be healthy and vigorous with no more evidence of plant disease or stress than is found on controls<br>• Plants must have healthy root systems<br>• There must be evidence of successful plants reproduction (e.g., seeds, rhizomes) |



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## APPENDIX 1

### Definitions

**1995 Criteria:** The criteria developed by stakeholders called *Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update*.

**Access Roads or Pads Left in Place:** Access roads or pads that will be left in place must support current or proposed future land uses. Such roads or pads must be stable, non-hazardous, non-erosive and must not affect drainage. Revegetation is not required for such roads, but weeds must be controlled. Pads left in place must be decompacted and revegetated, unless otherwise authorized.

**Alberta Environment: (AENV):** The department responsible for developing environmental programs, policies, criteria and standards for all of Alberta under the *Environmental Protection and Enhancement Act*. AENV inspectors and investigators have a mandate to oversee and enforce industry operations on private and public lands in Alberta.

**Alberta Sustainable Resource Development (ASRD):** The department responsible for land management on public land for those activities governed by the *Public Lands Act*. Also delegated inspection and enforcement of conservation and reclamation of industry operations governed by the *Environmental Protection and Enhancement Act* on public land.

**Assessment Grid**: A grid (typically 20 m by 20 m, to 30 m by 30 m) established on a site to provide a systematic pattern for collecting soils and vegetation data across the whole site. Assessments are normally made near grid centre.

**Bulk Density:** Dry bulk density ($D_b$) is to be calculated as the ratio of the mass of the dried soil ($M_s$)to the total soil sample volume ($V_t$), or $D_b = M_s / V_t$

**Control:** An off-site assessment point where the collected information is considered representative of the site, and will be used to compare with the on-site values.

**Cultivated Land:** Lands that have been continuously tilled or cropped and have a well-defined Ap horizon, including cultivated peat lands. These Cultivated Land criteria apply to lands under continuous and rotational cropping systems, haylands and forested lands that have been converted to continuous cropping or hayland systems. These Cultivated Land criteria do not apply to range improvement areas in grazing dispositions or reserves, which are assessed under the Grassland criteria.

**Forested Land:** Treed (bush) lands that are allowed to revert to forest or planted to forest species. These areas are either designated for multiple use (e.g., wildlife habitat, recreation) or for timber production. They include a mixture of private and public land. Many forested lands have severe limitations (e.g., soils, topography, access) that preclude cultivation. Land that has been converted to continuous cropping or hayland should be assessed under the Cultivated Land criteria. Land that has been converted to rangeland should be assessed under the Grassland criteria.

**Grassland:** Lands that are permanently grassed including, but not limited to, range improvement areas, grazing dispositions on public lands (White Area or Green Area), native prairie and



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grassland areas, Special Areas Board land, and Eastern Irrigation District land. Note that grasslands that have a well-defined Ap horizon, and have a reasonable likelihood of cultivation, are to be assessed under the Cultivated Land criteria.

**Ground cover:** The area of ground covered by all living and dead plant material, plus permanent erosion control products expressed as a percentage of a total area.

**Industry Assessment**: A detailed site assessment undertaken by an operator (or their consultant) where data for a certificate application are collected.
**Landowner**: Landowner, occupant, or land manager on Public Lands (ASRD).

**Lease:** Wellsite, excluding access road.

**Live plant cover**: The area of ground covered by all living plant material (stems and leaves) expressed as a percentage of total area.

**Live plant density:** The number of live plants or discrete stems per unit area.

**Particle Size Analysis (PSA):** The measurement of the proportion of sand, silt and clay fractions within a soil as determined by through sieving, or by their rates of settling in water.

**Peat Land:** Peat Land is found in poorly or very poorly drained depressions and level areas, and is saturated with water for prolonged periods. Soils are composed largely of organic materials, and are commonly known as peat, muck or bog soils. Peat Land may or may not be treed. The criteria apply only to those peat soils that have not been cultivated. All cultivated peat soils are dealt with under the Cultivated Land criteria.

**Plant pedestals:** The exposed plant roots and/or stalks as a result of wind and water erosion.

**Plant density** Number plants per unit area.

**Pre-Construction Site Assessment (PCSA):** An inventory and analysis of baseline landscape, soils, and vegetation data. Unique land characteristics (e.g. eroded knolls, saline seeps, previous disturbance) are also included. The PCSA data provide site-specific standards against which reclamation activities may be judged.

**Problem Introduced Forages**: Problem introduced forages were introduced purposefully by humans for crop/forage production purposes and either invade or persist in native plant communities. Introduced forage plants that have been identified as invasive or persistent in the southeastern mixed grass prairie areas of Alberta include crested wheatgrass and sweetclover. In the moister central parkland and in the foothills, timothy, smooth brome and reed canarygrass have been identified as problem plants.

**Process Restrictions**: Soil physical characteristics that have changed as a result of human activity on the land, and which may restrict air and water movement and therefore normal root development.

**Site**: Lease and the access road.

**Soil Profile Assessment**: An evaluation of the characteristics of the replaced surface soil and underlying subsoil. The purpose of the assessment is to ensure that there are no restrictions to rooting, or to water or air movement. The soil is assessed to a maximum depth of 60 cm.

**Surface Soil:** The uppermost soil layers that will be salvaged, and replaced to serve as a plant growth medium on a reclaimed site. For the purposes of the 2004 criteria document this includes the surface organic and mineral horizons, and possibly the Ae and/or upper portion of transitional A, and B horizons (e.g. AB, Bm – Chernozems; Bt - Luvisols). Thin peat soils may include a portion of the underlying mineral horizon (C).

**Topsoil:** All soil materials defined in Canadian System of Soil Classification (Agriculture Canada, 1998) as the mineral A horizon and surface organic (O, L, F, H) horizons.

**Two-Lift Stripping**: The selective salvage of all topsoil as the first lift and good quality upper subsoil as the second lift. The lifts must be replaced in the proper order during reclamation.



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## APPENDIX 2

### Process Restriction Indicators

| Vertical Root Elongation Restriction Indicators | Water Permeability Restriction Indicators | Soil Aeration Restriction Indicators |
|---|---|---|
| • Presence of early maturing crop with reduced height and density<br>• In mixed pasture or haylands, uneven distribution of species<br>• Uneven crop height and density in cropland<br>• Presence of root mats and bunches<br>• Presence of flattened and highly branched roots<br>• Presence of horizontal roots<br>• Presence of exped roots<br>• Absence of roots within or below reconstructed profile zones<br>• Absence of roots within soil aggregates<br>• Presence of soil layers or abrupt texture or structure transitions<br>• Presence of dense and massive soil structure | • Presence of surface ponding<br>• Presence of flooded (yellow or stunted) crop conditions<br>• Presence of surface vehicle (equipment) ruts<br>• Presence of dense, massive or layered structure (compaction)<br>• Presence of stratified or abrupt moisture changes within the soil profile<br>• Presence of abrupt texture or structure transitions | • Presence of dense, massive or layered soil structure (compaction)<br>• Presence of reduced pore size and pore space<br>• Presence of brownish-red ped surfaces<br>• Presence of sour odours |



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